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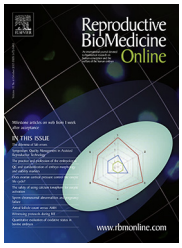

EDITORIAL

Analyzing IVF laboratory error rates: highlight or hide?

Over the last 35 years, IVF has transformed the treatment of infertility. Concurrently, IVF has become more complex due to the adoption of highly technological laboratory procedures, including cryopreservation of eggs and embryos, micromanipulation and pre-implantation genetic screening. In addition, the patient population being treated has broadened and often includes not only the intended parents but also gamete donors or gestational surrogates. As in other fields of medicine, these complexities have led to the adoption of more stringent control measures, such as time-outs and witnessing, to reduce the risk of errors. Unfortunately, the concept of errors in IVF has remained largely taboo from discussion and apart from sporadic reports in the press of major errors occurring after the birth of the wrong infant to IVF couples, little is known about error rates in the IVF laboratory. Therefore, data on such error rates are scant and answers to questions concerning the types of errors that occur, how often and how to minimize errors are needed to improve our knowledge.

Efforts to identify and reduce potential errors in general healthcare that predate the clinical introduction of IVF have centered largely upon viewing healthcare delivery as a series of processes and sub-processes which can be evaluated individually to produce improvement to the whole. One method adopted by healthcare units, actually developed outside of healthcare as a global method for process improvement, is Failure Mode and Effects Analysis (FMEA). One of the strengths of this approach is that it is proactive and can be invoked as a tool for identifying process errors as well as evaluating their correction. In the paper by Rienzi and colleagues in this issue of *RBMOnline* (Rienzi et al., 2015), FMEA has been used as a method for identifying real or potential breakdowns in processes and to develop strategies to mitigate risks in the IVF laboratory. They examined the risks associated with witnessing protocols before and after the implementation of an electronic witnessing system (EWS). The possible causes of failures and their potential effects were identified and allocated a risk priority number (RPN) for each failure. The most vulnerable steps identified were related to initial identification at the time of gamete collection or at gamete/embryo thawing. Subsequently, the group recognized that the possible causes of failures were mainly associated with heavy clinical workload and distraction, communication failures between the team and inadequacy of the labelling system used. These findings are in accord with studies evaluating the potential sources of errors in other clinical laboratories, highlighting that errors are least likely to be associated with the actual laboratory procedural or analytic event and more so with procedures that are pre-analytical (e.g. patient identification, test ordering, communication between the clinical and laboratory components of a unit) and post-analytical (e.g. accurate recording and reporting of findings), For example, Plebani (2006) showed that 46.0–68.2% of total errors occur in the pre-analytical phase while 18.5–47.0% happen in the post-analytical phase of testing. Clearly, the introduction of mandatory quality management practices in the IVF laboratory through accreditation and licensure is a major deterrent to procedural errors, however an unreliable chain of custody or system for traceability constitutes a serious threat to quality patient care even in the face of exceptional laboratory procedural competence. Encouragingly, after the implementation of the EWS, Rienzi et al. (2015) found that none of the vulnerable steps in the revised traceability system had a high RPN score. Re-evaluations conducted by the laboratory director 1 month and 6 months after completing the FMEA process confirmed that the introduction of electronic witnessing was successful in reducing potential risks. These are important findings but lead to the questions of what errors, other than those associated with traceability, occur in the IVF laboratory, in what processes and at what rate?

In a previous analysis of nonconformances from the Boston IVF Andrology and Embryology laboratories between March 2003 and November 2013 (Sakkas et al., 2014), a total number of 25,764 egg retrievals and 5,951 thaw cycles were reviewed. When taken into account that each cycle is comprised of multiple procedures including retrievals, cryopreservation, ICSI, PGS, and so forth, it was estimated that the total number of major procedures was approximately 128,415 during the study period. To characterize the error, they were graded as follows. Minimal: a problem not

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measurably decreasing likelihood of success; Moderate: a problem negatively affecting a cycle but not to the extent that it is lost; Significant: loss of a cycle due to loss/mishandling of gametes or embryos; and Major: systemic problems affecting multiple patients. In their analysis, moderate and significant errors were dominated by human error and equipment malfunctions. The most error-prone procedure was cryopreservation. During the 10.66-year period, the overall rates of moderate and significant errors per procedure and per cycle were 0.05% and 0.18% respectively. Combining moderate and significant errors resulted in error rates of approximately 1 per 1,735 procedures and 1 per 429 cycles. When significant errors only were counted, the rates were 1 per 8,026 procedures and 1 per 1,982 cycles. These rates compare very favourably with other areas of medicine, where the risk of adverse events due to laboratory errors ranges from 2.7–12.0%.

The Human Fertility and Embryology Authority (HFEA) has also published reports on the number of incidents involving IVF clinics in the United Kingdom (HFEA, 2011; HFEA, 2012). They defined an "adverse incident" as:

> ". . . any event, circumstance, activity or action which caused, or had been identified as potentially causing, harm, loss or damage to patients, their embryos and/or gametes, or to staff or a licensed centre. This included serious adverse events, adverse reactions, breaches of confidentiality, and OHSS, which required a hospital admission and had a severity grading of severe or critical."

In the last 2 reports, 571 and 499 incidents were reported. Of these reports the severity ranged from A [severe] to D [minor] and the incidence from April 2009 to March 2011 was 7, 580, 395 and 36 respectively for A, B, C and D. Interestingly, the French Agency of Biomedicine has also instigated a reporting mechanism aimed at documenting the safety and quality of assisted reproductive technology (ART). In 2012, 84 IVF clinics reported 477 adverse events. Both these reports also included clinical events and were not solely focused on the laboratory (Agence de la Biomedecine, 2013; Pariente-Khayat et al., 2011).

Rienzi and colleagues (Rienzi et al., 2015) conclude that due to the irreversible and dramatic consequences of mismatches in IVF, it is suggested that safety can be enhanced by performing proactive risk-assessment analysis and by considering the implementation of EWS to prevent potential risks. The limited data available to date demonstrate that ART laboratories do well with respect to nonconformances compared to other medical laboratories. It is imperative that all IVF laboratories utilize a quality management system of some type to track nonconformances and implement systems to learn from them so as to improve and keep them to a minimum. The Boston IVF data indicate that more than 99.9% of procedures proceeded with no nonconformance event and most nonconformances in the laboratory were minor. This, again, attests to the excellent processes implemented by ART laboratory programmes. Still, the additional task of tracking errors, as failure modes, nonconformances or as sentinel events, is essential to providing quality patient care in the IVF setting. Essential, yes, but it need not be complicated. One approach is to grade laboratory errors on the basis of their seriousness and include in the analysis the harm to patients and worst-case scenario should the error be repeated. This can lead to effective system redesign that addresses errors, such as those related to communication between clinic and laboratory (Plebani, 2010). Another common method, once an error has occurred, is Root Cause Analysis (RCA), now required in all healthcare agencies, including IVF laboratories, that are accredited by the Joint Commission on Accreditation of Healthcare Organizations in the USA (Williams, 2014). A number of tools are available to perform RCA but perhaps the simplest is to ask "why" five times, starting with the untoward event and ending, after five cycles of "why", with the cause upon which repair can be addressed. Unlike FMEA, it is employed after the fact but has the advantage of providing a grand overview of a process along with minute details. Further, process improvement need not be a prolonged endeavour and methods such as the Model for Improvement (Langley et al., 2009) are available to accelerate the undertaking. By keeping track of nonconformances it is much easier to prevent more serious ones and it also allows for maintenance of high safety levels for patients attempting complex IVF procedures. Indeed, Kachalia (2013) stated that "no matter how daunting the task, shining a light on errors shows a path to improvement".

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